Graduate Education in Geographically – Integrated History: A Personal Account

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ABSTRACT: This article discusses graduate education in geographically–integrated history as developed by the History Department of Idaho State University for its M.A. in Historical Resources Management. This Master's program is based the use of geographic information systems (GIS) and related information technologies. In addition to discussing the rationale and design of the program, the article illustrates what is involved in graduate education of this type through a description of the author's introductory graduate course "Geographic Information Systems in Historical Studies."

GRADUATE STUDY OF GEOGRAPHICALLY–INTEGRATED HISTORY

As I have made clear in several recent publications, my interest in developing a new type of historical research and teaching extends back to the late 1960s.[2] In general terms, in order to understand the past, we must be able to do three things that are the hallmarks of geographically–integrated history. We must be able to integrate information about the natural, social, and cultural environments, to deal with complex systems, characterized by nonlinear dynamics prevalent in the natural world and human history, and to write and teach "connected histories" that stress the ways that the history of any place has been shaped by its connections to other places and the changes in these links.[3] To achieve this integration of all possible historical information on the basis of place (for example, original written documents and photographs; digital text, image, and tabular data) will demand that historians "georeference" their information to both place name and the geographic coordinates of longitude and latitude in decimal degrees.[4] If the product is digital, the resulting database constitutes a body of knowledge that will remain open to the future input of additional information and the correction of errors.

On an institutional basis in the United States, the discipline of history is increasingly confronted by a crisis growing out of the financial problems of colleges and universities and their increasing stress on obtaining external funding. In other publications, I show how geographically–integrated history provides a path for historians to obtain the type of external research funding that draws favorable attention from the administrators of their schools.[5] In this article, I will discuss how the History Department of Idaho State University seeks to prepare graduate students to undertake geographically–integrated history so that they will have available to them

a broad range of interesting employment and educational possibilities once they complete the degree program. We had become depressed by the sight of so many anxious, disappointed job-seekers at American Historical Association meetings, and we specifically designed this program to enhance significantly the employment opportunities of students with strong, traditional disciplinary training by introducing them to the unrivaled means of geographic information systems (GIS) and related information technologies to explore, analyze, and visualize historical resources, the interactions among them, and their relationship in space and time; to catalogue, connect, and distribute historical resources on local and global scales; to develop public policy; to formulate questions for analysis; and to present the results of such work in response to research problems posed by individual researchers, community groups, public entities, and private institutions. Although some of the employment possibilities overlap those on which "public history" programs concentrate, a graduate of our program will find a much broader range of possibilities, including entrance into doctoral programs or jobs in the K-12 education sector. In discussing this graduate program, I present only my own views and not those of my colleagues who might have other perspectives on graduate education in this type of transformative historical research and teaching.

Despite this disclaimer, I want to stress that this ambitious teaching program could only be undertaken because my department recognized the degree to which the humanities are under attack at many institutions of higher learning.[6] The inability of humanities departments to attract large research grant funding has put them in a precarious budget position on many campuses. In the midst of some institutional crises, existing history departments may disappear as the remaining history courses will be housed within other units, which will undermine the discipline's contributions to critical, research-oriented thought. My department decided to shape its own future rather than waiting to react from a position of weakness. We could take advantage of our unusual cohort of historians interested in geographically-integrated history and the flexibility we have because of our small size to reshape ourselves in ways that would attract favorable attention and additional resources for positions, salaries, facilities, capital outlay, and library support from the university's administration, link us to politically important external constituencies, permit us to submit innovative proposals to funding sources underexploited by historians, and position our graduate and undergraduate students to obtain good jobs upon graduation. To achieve these goals, we decided to occupy a niche created by the growing number of historical research projects informed by geographically-integrated history and the use of GIS and related information technologies.[7]

Whenever I am asked to speak about the use of GIS for historical research and teaching, I use a PowerPoint slide with the text:

GIS History
Historical GIS
Geographically-Integrated History
What's in a name?
The core of the
M. A. in Historical Resources Management

In discussing the question in the slide, I explain that I reject the use of the first two terms because I feel it is a mistake to tie ourselves to the current forms of GIS software. The software is too limited now to address all of the needs of historians.[8] I created the term "geographically-integrated history" because I wanted to stress that our efforts to transform history and the historical social sciences go well beyond what current GIS software can deliver. If we want to teach history in a way that integrates information on the basis of geographic location and connects these locations through a variety of interactive networks, we cannot constrain ourselves by an exclusive reliance on current GIS's layer-based data model, its weakness in visualizing attributes or themes, and its inability to deal adequately with time. Instead, we need to follow a vision that encompasses both what current GIS software can do and the elaboration of ways to meet our other needs. The effective education of graduate students must do both things at the same time.

BIRTH PAINS

Idaho State University's History Department was able to start our first graduate program in geographically-integrated history, the M.A. in Historical Resources Management, in August 2007. The nature of its core courses will undergo some changes for two reasons. First, although Laura Woodworth-Ney and I did not realize it when we first created this program in October 2002, our graduate program is the first of its kind in the world. Not surprisingly, our idealized initial vision will need to be trimmed a bit to the reality of educating graduate students.

Second, we needed a new departmental line in order to start the graduate program after its approval by the State Board of Education in March 2005. Laura and I had predicted that this new graduate program would provide us with a basis for obtaining external research funding. However, the only way to extract this faculty position from the ISU administration was to pursue such funding before the graduate program began and tying its start to the funding proposal itself. In May 2006, I built such a tie into my proposal of a multi-national, multi-disciplinary research project (the acronym for which is DynCoopNet) for the European Science Foundation's EUROCORES (European Collaborative Research) Scheme's program "The Evolution of Cooperation and Trade" (TECT).[9] I became eligible to propose a project to this European program

because the U.S. National Science Foundation (NSF) decided to support TECT. Any NSF proposal must include two mandatory sections dealing with "Intellectual Merit" and "Broader Impacts". For the latter section, I argued that my project, in part through the development of a graduate program in geographically-integrated history, would transform research in the historical social sciences, geographic information science, and mathematical modeling in economics and geography. Thus, after my proposal surprised many of my European colleagues in history by surviving the first cut by the TECT international review committee, ISU's administration had to decide whether in the midst of financial crisis, to give my department a new position or walk away from a chance to obtain NSF funding that would bring considerable money to the institution through the payment of indirect costs. After several tense months, we were given the new position and hired an historical geographer, Sarah E. Hinman, who obtained her Ph.D. from the Geography Department at Louisiana State University. Now, no one will play poker with me.

To provide instructional flexibility to our small department, Kevin Marsh, the well-known environmental historian we hired in 2003, Laura, and I developed the background necessary to teach any of the core graduate courses. Because it is tied with the new "spatial" emphasis of our undergraduate major program, I had already developed one of these courses, entitled "Cartography: History and Design," in 2006. With Sarah's addition in the fall of 2007, we should have had even more flexibility. However, Laura became department chairperson at that time, and my NSF funding reduces my fall teaching and eliminates entirely my spring teaching and, therefore, my ability to teach during that semester either of two graduate courses I had already prepared. These circumstances have forced a slight reorganization in the core of the M.A. program without pulling us away from its goals. This process will continue because we are part of the creation of a Ph.D. program in Human Ecology and Social Dynamics (with the departments of Anthropology and Geosciences) that is now moving through administrative channels toward approval. Therefore, the structure of the M.A. program that I present in the next section should be considered something of a work in progress.

GRADUATE PROGRAM DESIGN

Because Laura and I have already published an article about the creation of the M.A. program,[10] I will limit myself to a brief description of what we sought to accomplish and the curricular design we created. Just about the time that we realized that we would have to create a graduate curriculum from scratch, the American Historical Association's magazine *Perspectives* published in March 2003 an article about the results of an employer survey done by the AHA's Taskforce on Public History.[11] Although the range of employers surveyed was narrower than that toward which ISU's program would be directed, the glaring deficiencies the survey exposed appeared to be

those we should address. According to employer responses, graduates of existing public history programs lack sufficient understanding of the use of primary sources and of the major contemporary debates in the secondary historical literature, they are often poorly prepared for collaborative work, and they lack communications skills. We decided to develop a curriculum that focused directly on these deficiencies so that subsequent assessments of employer satisfaction with our graduates would highlight their strengths in these areas. From our experiences with employment situations and GIS, we added two additional concerns. We wanted our graduates to know how to draft effective funding proposals, and we included visual communication, along with written and oral forms, among the communication skills they should develop.

Because history as a discipline has customarily stressed individual work, it made sense that our students would not know how to function in a collaborative physical or virtual environment. As a rule, historians know nothing about the norms of collaborative research and publication, which are common in other disciplines, and collaborative forms of teaching and learning have only recently begun to penetrate university history classrooms.[12] Therefore, the ISU history department created as the capstone of our graduate program an internship experience within a collaborative environment that will allow us to "coach" our students in ways they can interact more effectively with others. Because this emphasis on collaboration and building effective teams has traditionally not played a role in the training of historians, we are convinced that our graduates will stand out among applicants for history-related jobs.

In addition to its benefits for the students, we expect that some of these internships will link us to institutions and private enterprises that will become part of our external constituency to promote the history department to ISU's administration and politically significant groups in Idaho. Other internships will involve participation in multidisciplinary, collaborative research projects that the history department will develop as a result of our research emphasis on large-scale, geographically-integrated historical studies. For example, the two graduate research assistants currently supported by my NSF grant will likely do their internships with a research institute in the Brazilian state of Pernambuco and with researchers at the Technical University of Madrid who are developing spatial-temporal software for geographically-integrated history. I had no such opportunities for collaborative work available to me as an M.A. student.

To make sure that ISU's history graduate students are prepared for their internships, we designed five, integrated core courses for the program's first year to address the employer concerns uncovered by the Public History Taskforce's survey. Compared to the offerings of other history departments, our program includes several unusual courses. During the fall semester, beginning students receive an introduction to the use of GIS in historical studies, they study cartographic design and the history of

cartography, and they participate in a historiography proseminar in which students focus their attention on contemporary debates related to location and spatial relationships. In the spring semester, students take a lab-based course, entitled simply "Presentation of History Projects," and a class in which they learn how to discover funding sources for historical research and its application and how to write successful funding proposals. Throughout, activities and discussions are focused in ways that encourage the students to think of themselves as a collaborative cohort or team responsible for promoting the learning of all of its members. The ISU history department feels that our Master's program in geographically-integrated history fosters among students unconventional thinking, creativity, and a passion for historical studies as a basis for understanding all human activities and the evolution of complex communities at any scale. With the foundation these integrated core courses provide, the interns will have a substantial impact on those with whom they work.

Because we want our graduates to have strong traditional training, they also take a minimum of twelve semester credits in history courses beyond the core courses and internship. To be admitted to the graduate program, applicants must have at least eighteen semester credits of previous course work in history at the upper-division level. Effective employment of GIS requires substantial disciplinary knowledge, for although historians using this powerful information technology are able to ask new questions about the past and present their arguments striking ways, they, not the tool, must provide the answers, and this will still be the case when we expand the organizational and analytical tools available for geographically-integrated history. Many of these courses also support ISU's undergraduate history major, which has a distinctly "spatial turn." For example, we provide majors with opportunities to understand: cartographic representations of spatial features and relationships and of historical developments; regions as historical entities, including change in their spatial dimensions and characteristics over time; how places are connected and how these interconnections have changed over particular periods; and how local developments are linked to regional or global themes.

In addition to the elective courses in history, graduate students also take courses in GIS and related information technologies depending on their plans for their internships and future employment. All of them will have taken an introductory GIS course prior to admission, but they may take at the graduate level courses on advanced GIS and related information technologies, programming, spatial analysis, modeling, web design, and museology, among others.

IMPORTANCE OF GIS

I do not wish to diminish in any way the important contribution of current GIS to our graduate instruction. Georeferenced information can be used in ways that

compensate for humans' weak cognitive capacity to grasp spatial relationships, and we greatly enhance the investigation and teaching about historical questions with which members of the ISU department often deal, such as the environmental, social, and cultural impacts of human movement and settlement in western North America. Both researchers and students find it difficult to organize and understand the rich body of information that results from such georeferencing, and in order to manage, integrate, and analyze data, we employ GIS and related information technologies.

A lack of general public knowledge about GIS still hurts our ability to build the graduate program. Those managing everything from municipal services to disaster response and war depend on GIS, but despite its ubiquity, most people do not know the technology exists or often confuse it with Global Positioning Systems (GPS). Oversimplifying a bit, GIS permits us to treat each data type as a separate layer, which can, on the computer screen, overlay other data layers to see relationships among them. When their information is organized in this form, historians find it much easier to recombine and disaggregate data, to display selected features, and to explore what is known in ways that expose unexpected relationships and facilitate analysis of complex problems. As the authors of the *LaPietra Report* (cited in note 2) correctly emphasize, the history of no place can be adequately understood without taking into account how that place has been connected to other places, and GIS facilitates linking and comparing places within different spatial scales. Particularly when a place is a country or large region, it is difficult for a single historian to master what is known about multiple locations, and GIS provides an excellent platform for multi-disciplinary collaboration among researchers. Finally, GIS permits visualization of relationships. Visualization reduces the cognitive weight on even the experienced analyst when the quantity of information is great, a problem is complex, and alternative solutions are numerous and surpass the capabilities of human reason. The visualizations employed for data exploration and analysis can often be transformed into striking supports for teaching and public presentations. Particularly when founded on some form of cartographic representation, visualization draws students and those who attend public meetings or lectures more quickly into discussion and analysis, better supports their memory of significant details, and more rapidly increases their thinking performance than consideration of the same issues without the use of visualization.[13]

TEACHING CURRENT AND FUTURE GIS

Obviously, it is not easy to combine into a program for graduate education both a strong grasp of what can be done with current GIS software and an understanding of what the future will likely bring to the discipline. Because it is intended as the first semester, introductory course for geographically-integrated history, I use my course "Geographic Information Systems for Historical Studies" (History 610), which is open

only to graduate students with a background in GIS, to provide as broad a perspective as possible. At the same time, the students in the M.A. in Historical Resources Management program take together "Cartography: History and Design" and a topical proseminar, and we try from the beginning to build among them a spirit of collaboration and team work in their activities.

In order to focus student attention on the diverse topics presented in History 610, I assign a semester project based on a set of assumptions. The project must encourage student collaboration, permit application of a number of current GIS capabilities, and force both the development of significant spatial questions that are also historical and thinking about what geographically-integrated history might become. The assignment postulates that the first global age, roughly from 1400 to 1800, constituted a complex, dynamic, nonlinear system.[14] This system was created through the diffusion of interactive social networks of commerce, institutional authority, and information throughout the world. These networks were self-organizing in the sense that they depended on interactions among individuals and groups that were difficult or impossible command or control with any reliability. Within a system, such networks are typically the source of creativity and innovation and lead to the emergence of new forms.[15]

Although there are a large number of factors present in such a complex system, in any complex system only a few variables, sometimes only one, maintain the system's stability. Significant systemic change occurs when these stability-maintaining variables, which are always close to instability, pass into a situation of instability that destabilizes the entire system, and its elements reorganize, in a process often called bifurcation, to produce a new system.[16] Because people living in the new system respond to different values and perspectives about the world from those of their ancestors in the old system, they have trouble understanding their predecessors. The project assumes that the system of the first global age went through a phase transition to a new system during the period 1750 to 1850. Intellectual leaders of the second global age imposed upon the earlier period linear metanarratives that culminated in what they felt were the characteristics of their own time (for example, the rise of the State; the rise of Capitalism; the rise of the Modern Individual or Individualism), which profoundly shaped the development of history as an academic discipline.

When dealing with a complex system characterized by nonlinear dynamics, it is essential to stress that systemic stability does not mean that nothing happens. Although I would not want to push too far the analogy with human systems, the weather is a complex, dynamic, nonlinear system, and we would not watch weather reports if we thought that nothing different ever happened. In other words, a great deal of turbulence can be present. The reference to weather does underline another

important characteristic of nonlinear dynamics: predictability is very limited despite determinism. This is why a weather forecast is seldom reliable more than five days in advance.

For their individual projects, students select topics that might reveal something about the nature of the first global age in the eighteenth century and the factors maintaining stability or about the transition to the second global age. At the end of the semester, they present their projects orally, visually, and in writing. The projects are evaluated according to the following rubric.

Project evaluation rubric

The following rubric will be used to evaluate your work on the course project. In making my evaluation, I will take into account both your written project and your oral "PowerPoint" (or other software) presentation on the final evening of the course (during final exam week). Remember that you will achieve a high professional standard for both.

If you need an explanation of any of the rubric headings, please ask and I will provide a more detailed written discussion of the heading.

The project is designed to address the shortage of spatial questions in the discipline of History. The project is predicated on the assumption that the First Global Age, 1400–1800, represents a complex, dynamic, non-linear system, which appears to have undergone a major phase transition sometime in the period 1750–1850 out of which a new system developed. Your project will help researchers investigate the nature of the system of the first global age, the phase transition, and the new system (perhaps not all at once).

1) Determination of the project's subject in relationship to the description of the global system and its phase transition (including the quality of the title and abstract): 0 – 10 points

2) Description, location, languages, types of data in archival or other sources (e.g., maps) available to carry out your project (if you were to do so) 0 – 10 points
[Note: you will want to attach a list of the works from which you derived this information about archival sources.]

3) Definition of important historical questions that can be answered on the basis of the data you describe (with high marks for really good spatial questions that are also historical) and differentiation of the value of these

questions in reference to the projects about which you have read for this course (with proper citations according to the Springer-Verlag style manual you were given): 0 – 10 points
[Note: remember that I suggested that you put these questions in some sort of order, probably by importance. I quote from the original assignment: "A significant spatial question would be one that is so important that you cannot understand the subject without an answer."]

4) Explanation of how GIS would be used to organize, explore (query), and analyze the available data (with proper citations according to the Springer-Verlag style manual you were given): 0 – 10 points

5) Explanation of the types of cartographic visualization you would employ and the differentiation of your choices from those made in the projects about which you have read for the course: 0 – 10 points

6) Explanation of what your project, if you could generate the necessary data and carry it out, might tell us about the major transformation of the world system that apparently took place during the period 1750 to 1850: 0 – 10 points

Because for every week of the course, students prepare short papers, and sometimes PowerPoint presentations, about how they might use what they have learned,[17] there are ample opportunities for them to develop the necessary sections of their project and to receive feedback from the instructor and the other students to help them with difficulties (and to develop their collaboration and communication skills). Some of the most relevant weekly units for the project are those about digital gazetteers and metadata, the use of historic maps,[18] the introduction of time, forms of visualization, and spatial analysis. Whenever possible, students must grasp the existing techniques described and demonstrated in the three required books[19] and other readings, but they must also recognize when these techniques do not allow them to deal well or at all with some of the available information.

Other weekly units focus attention on additional issues that might not be specifically germane to an individual student's project. For example, for the second week of class, we tour one of Pocatello's historic neighborhoods to talk about how GIS might be used to study the built environment. Students must each write a memo as a consultant for the Bannock County Historical Society in which they convince Pocatello's city council to fund a GIS-based history project dealing with the neighborhood they have toured. They are told that council members will know little about GIS and will care little about history or historic preservation. The assignment encourages them to treat seriously the simulated assignments, to develop effective

means to describe technical projects to an audience unfamiliar with the techniques, and to understand the perspectives of people who do not share their evaluation of the importance of historical studies. Because of the close ties between the development of GIS software projects and environmental studies,[20] we also spend a week examining the application of GIS to environmental history.

Toward the end of the course, we spend two weeks examining well-known historical infrastructure projects, such as the China Historical GIS (http://www.fas.harvard.edu/~chgis/), the Great Britain Historical GIS (http://www.gbhgis.org/), and the National Historical Geographic Information System (http://www.nhgis.org/), and other GIS related projects of a more thematic nature, such as the Old World Trade Routes Project of my DynCoopNet colleague T. Matthew Ciolek (http://www.ciolek.com/owtrad.html), the Electronic Cultural Atlas Initiative (http://www.ecai.org/), the International Dunhuang Project (http://idp.bl.uk/), and the Polis Center's North American Religion Atlas (http://www.religionatlas.org/). We expect our graduates to be conversant with the major initiatives around the world to use GIS for historical research, and the documentation of these projects often exposes well both the advantages and limitations of current GIS software for such work.

It is worth stressing the degree to which ISU's graduate program places an emphasis on visualization. Visualization is a primary focus of two of the five core graduate courses ("Cartography: History and Design" and "Presentation of Projects"), and it receives considerable attention in History 610, "Geographic Information Systems in Historical Studies." There are three reasons for this emphasis. First, it is an important component of the professional communication skills we want all of our graduates to demonstrate. In terms of increasing our understanding of historical reality, we use visualization to reduce the cognitive weight when the alternatives are numerous and surpass the capabilities of human reason. However, my colleagues and I also recognize that the creation of effective visualizations for the comprehension and communication of the spatial-temporal form of the world and its processes is fundamental for the implantation of this type of research and teaching within the disciplines of history and the historical social sciences.

Over the past decade, I have given to audiences of historians many papers and other presentations about the use of GIS for research and teaching. From my own research and classroom experience and the reactions of others to my presentations, I know that there are two major sources of historians' frustration with using GIS: (1) the difficulty of handling time, and (2) the requirement of precise or crisp data when so much historical information is riddled with vagueness and uncertainty. In an introductory graduate course such as mine, I think it is important to encourage the students to think about how such problems might be handled in the future. The nature

of the student projects invites constant discussion in and out of class of these issues and brings to the fore the importance of mathematics and multi-disciplinary collaboration.

In an important 2004 article, Michael Goodchild pointed out that time could be incorporated into GIS only through the use of mathematical expressions, an assertion that he has since ratified in a number of public presentations.[21] In the course, I present students with two categories of expressions that must be integrated into GIS in order to deal with temporal processes that are crucial for the advance of historical understanding and the contextual situation of narrative. The first is expressions involved with the analysis of object-field dynamics. Such dynamics involve several classic problems in geography and the historical social sciences such as the diffusion of innovations and social networks analysis. In formal terms, this analysis concerns networks (topology), connectivity (density; characteristics of nodes), and the clustering and distribution of data and their surroundings. Some elements of fields of interest for historians, for example political ideologies, will have only irregular intersections with geography.[22] The second is expressions for the analysis of bifurcations and indications of the emergence of new forms (evolution) in complex, dynamic, nonlinear systems.[23] At least in passing, I try to introduce two other possible future developments related to the representation of patterns and spatial-temporal relationships through spatial-temporal modeling: (1) the integration of different modes of inference (requiring research on ontology/semantics) without depending on similar bases of understanding (requiring research on high-speed computing); (2) the integration into the databases of "documents" to explain the sources of the data and to expose the conclusions of the analysts (perspectives of experts from different disciplines).

In the GIS world, concern about information vagueness and uncertainty is not confined to historians, although others seem more willing to ignore how profound the clash between precision and vagueness really is. To create a context, student attention is drawn to a section of one of their textbooks, "Vagueness of Georeferencing" by Linda Hill. She clearly indicates the dimensions of the problem for teaching when she asserts that: "Vagueness is not handled well by GIS or by cartography in general where a boundary must be placed somewhere. Users place more confidence in such lines and points than they should. Specificity is forced on the representation even when the data may indicate that a range of values or probabilities for boundary data points is more appropriate."[24] I point out to the students that, although, surprisingly, it has not received much attention in the GIS world, there is a solution that is now being explored. This solution exploits fuzzy set theory, developed since 1965 by Lotfi A. Zadeh.[25]

Those of us interested in the use of GIS for historical research and teaching –and at

the graduate level the two matters are inseparable—we are in for some dazzling developments that will transform our discipline. Traditional narrative is linear and poor at capturing the complex, multi-dimensional, nonlinear nature of reality. Cartographic visualization is weak on presenting the multiple themes or attributes that are necessary to enhance our understanding of reality, and it poorly conveys anything relating to time. We will soon see the emergence of forms of geographically-integrated history that provide us with thematic richness, complexity, non-linearity, multi-dimensional analysis, and even fuzzy logic and simulation. In a challenging and constantly changing technological and employment environment, the ISU History Department wants our graduate students to be prepared to compete for the best jobs and post-graduate educational opportunities. Because historical scholarship and thought are not necessarily tied to traditional forms of individual research projects and monograph publication, we are convinced that historians can and must embrace new forms of research organization and rapidly evolving types of information management and analysis. The alterations will unsettle us, but if history as a discipline is to retain a viable place in the academy and public intellectual life, we must embrace change and shape it to serve our needs. We hope to matriculate students fascinated by revolutionary, digital tools of communication and information management and their potential for historical research and teaching, and we want to transform them into the leaders of the next generation of historians.[26]

Endnotes

[1] J. B. Owens is Director, Geographically-Integrated History Laboratory
Idaho State University and a professor of History.

[2] J. B. Owens, "What historians want from GIS." *ArcNews*, 29, 2 (summer 2007): 4-6, and
http://www.esri.com/news/arcnews/summer07articles/what-historians-want.html, accessed 22 October 2008; J. B. Owens, "Toward a geographically-integrated, connected world history: Employing geographic information systems (GIS)." *History Compass*, 5, 6 (October 2007): 2014-2040, 10.1111/j.1478-0542.2007.00476.x. "Historical Studies, GIS for," in Karen Kemp (ed.), *Encyclopedia of Geographic Information Science* (Thousand Oaks, California: Sage, 2008): 220-21. The first article listed has been reprinted in *GIS Best Practices: Essays on Geography and GIS* (Redlands, California: ESRI, 2008): 35-46, which is a free e-book available at the URL http://www.esri.com/library/bestpractices/essays-on-geography-gis.pdf, accessed on 22 October 2008.

[3] On this latter point, see sections I and II of Organization of American Historians, *LaPietra Report: A Report to the Profession* (2000),

http://www.oah.org/activities/lapietra/final.html, accessed on 22 October 2008. This document constitutes a devastating attack on the way U.S. history is generally taught. Its central point is that because the history of any place has been profoundly shaped by the way that place is connected to other locations and the changes in the pattern of those interactions over time, you cannot make sense of U.S. history without taking into account the ways in which the country has been linked to other places in the world.

[4] For a clear synthesis of this concept and its implications, see Linda L. Hill, *Georeferencing: The Geographic Associations of Information* (Cambridge, Massachusetts: MIT Press, 2006).

[5] J. B. Owens, "A Multi-national, Multi-disciplinary Study of Trade Networks and the Domains of Iberian Monarchies during the First Global Age, 1400-1800." *Society for Spanish and Portuguese Historical Studies: Bulletin* 32, 2 (in press); J. B. Owens, "Space, connections, and place in the first global age." *Sixteenth Century Journal* 40 (in press for a special "Future-spectives" issue). I am currently funded by the U.S. National Science Foundation (NSF) for creating, directing, and participating in a multi-national, multi-disciplinary research project (Award number SES-0740345; $394,000; 2007-2010). I describe this project in "Dynamic Complexity of Cooperation-Based Self-Organising Networks in the First Global Age (DynCoopNet)," in Ronald Noë, Rüdiger Klein, Julia Boman, and Claire Rustat-Flinton (editors), *The Evolution of Cooperation and Trading (TECT)* (Strasbourg, France: European Science Foundation, EUROCORES Programme, 2008 [ISBN 2-912049-83-0]): 23-35. This book can be downloaded in pdf at the URL http://www.esf.org/activities/eurocores/programmes/tect.html, accessed 22 October 2008.

[6] Robert B. Townsend, "A Wake-up Call for the Humanities," *Perspectives*, 45:2 (February 2007), 7.

[7] A good cross-section of such projects is included in Anne Kelly Knowles (ed.), *Past Time, Past Place: GIS for History* (Redlands, California: ESRI Press, 2002).

[8] These limitations are well outlined in an excellent book that I now use as a textbook in one of my courses: Ian N. Gregory & Paul S. Ell, *Historical GIS: Technologies, Methodologies and Scholarship* (Cambridge, UK: Cambridge University Press, 2007).

[9] See the information on the project in note 4.

[10] J. B. Owens and Laura Woodworth-Ney), "Envisioning a Master's Degree Program in Geographically-Integrated History." *Journal of the Association for History and Computing* 8, 2 (September 2005), http://mcel.pacificu.edu/jahc/2005/issue2/articles/owenswoodworth.php, accessed on 22 October 2008.

[11] Philip M. Katz, "Public History Employers-What Do They Want? A Report on the Survey," http://www.historians.org/perspectives/issues/2003/0309/0309aha6.cfm, accessed on 22 October 2008.

[12] In order to address this deficiency in the history profession, my TECT research project has developed the "DynCoopNet Guidelines for the Use of Shared, Distributed Data, Collaborative Research and Joint Publication," which is available in the TECT book cited in note 4, pp. 34-35.

[13] These visualizations of reality are abstractions, and like the articles and books written by historians, which are also abstractions of reality, cartographic and other visualizations should be judged on the degree to which they increase our understanding of the real world. This point is central to David J. Staley, *Computers, Visualization, and History: How New Technology Will Transform Our Understanding of the Past* (Armonk, New York: M. E. Sharpe, 2003).

[14] The rough chronological limits of this period are taken from Andre Gunder Frank, *ReORIENT: Global Economy in the Asian Age* (Berkeley and Los Angeles: University of California Press, 1998).

[15] For a valuable discussion of approaches to social network analysis, see Gernot Grabher, "Trading routes, bypasses, and risky intersections: mapping the travels of 'networks' between economic sociology and economic geography," *Progress in Human Geography* 30, 2 (2006): 163-189. Grabher is a member of an interesting program "Socio-Economics of Space" at the University of Bonn, Germany. These social networks of the first global age draw my attention because of the large clandestine economy and high rates of smuggling that have great significance for cooperation in trading, information flows, and the exercise of political authority.

[16] This understanding of complex systems is based on Hermann Haken, *Advanced Synergetics: Instability hierarchies of self-organizing systems and devices* (Berlin et al: Springer-Verlag, 1983). As a foundation for discussions of this systemic perspectives, students read chapter 12 of a book by economist Tönu Puu, who is one of my DynCoopNet collaborators: *Attractors, bifurcations and chaos: Non-linear phenomena in economics* (2nd ed.; Berlin & Heidelberg: Springer-Verlag, 2003). For

those who are puzzled by the mathematics, I suggest they read chapter 7 of Tönu Puu, *Arts, sciences, and economics: A historical safari* (Berlin & Heidelberg: Spring-Verlag, 2006). The idea that those living in a period characterized by a complex system would understand only with great difficulty people of earlier systems comes from a lecture given to ISU's Mathematics Seminar in February 2006 by my DynCoopNet colleague Michael Sonis, a mathematician who is a retired member of the Geography Department of Bar-Ilan University in Israel. Those who wish a broad introduction to nonlinear dynamics in complex human systems (the "house of discontinuity") should read the early chapters of J. Barkley Rosser, Jr., *From catastrophe to chaos: A general theory of economic discontinuities* (2nd ed.; Boston et al: Kluwer Academic Publishers, 2000).

[17] The complete course syllabus is available at the URL http://www.isu.edu/~owenjack/gishist/syllabus.html, accessed 22 October 2008.

[18] To add in the use and evaluation of historic maps, I recommend to readers the free and easily mastered application MapAnalyst, which was developed by Bernhard Jenny of the Institute of Cartography, ETH Zurich, http://mapanalyst.cartography.ch, accessed 22 October 2008.

[19] Gregory and Ell, *Historical GIS*; Hill, *Georeferencing*; and Anne Kelly Knowles (ed.), *Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship* (Redlands, California: ESRI, 2008).

[20] Including the MapWindow software of ISU's geospatial software laboratory, which is free and comes with a clear instructional manual, available in pdf on the MapWindow web site, that serves as an excellent teaching guide for learning GIS (http://www.mapwindow.org/, accessed on 20 October 2008).

[21] Michael Goodchild, "GIScience, geography, form, and process." *Annals of the Association of American Geographers* 94, 4 (2004): 709-714.

[22] My ideas about this category to temporal processes have been heavily influenced by work with my DynCoopNet project colleagues Monica Wachowicz, whose 1999 book *Object-Orientated Design for Temporal GIS* (London: Taylor & Francis) is a temporal GIS classic, and May Yuan, whose 2008 *ArcNews* article "Dynamics GIS: Recognizing the Dynamic Nature of Reality" (*ArcNews* 30, 1, pp. 1, 4-5, and http://www.esri.com/news/arcnews/spring08articles/dynamics-gis.html, accessed 20 October 2008) is assigned reading for the course. I was also heavily influenced by the presentation of Michael Goodchild at the 2006 "Computation and Visualization for the Understanding of Dynamics in Geographic Domains" workshop of the University

Consortium for Geographic Information Science (UCGIS), which is available at the URL http://www.ucgis.org/dynamics_workshop/workshop_agenda.htm, accessed 20 October 2008. For a development of this presentation, see Michael F. Goodchild and Alan Glennon, "Representation and Computation of Geographic Dynamics," in Kathleen Steward Hornsby and May Yuan (eds.), *Understanding Dynamics of Geographic Domains* (Boca Raton, Florida; London; and New York: CRC Press, 2008): 13–29. There is a fascinating company book to this group of essays: May Yuan and Kathleen Stewart Hornsby, *Computation and Visualization for Understanding Dynamics in Geographic Domains: A Research Agenda* (Boca Raton, Florida; London; and New York: CRC Press, 2008). Unfortunately, these books are too expensive to assign for my class in addition to the books students must already purchase. However, they do read Michael F. Goodchild, "Combining Space and Time: New Potential for Temporal GIS." In Anne Kelly Knowles (ed.), *Placing History: How Maps, Spatial Data, and GIS are Changing Historical Scholarship* (Redlands, California: ESRI Press, 2008), 179–197.

[23] See the references in note 15.

[24] Hill, *Georeferencing*, pp. 28–29. The quotation is on page 29.

[25] A full bibliography of Zadeh's major papers can be found in Lotfi A. Zadeh, "Toward a theory of fuzzy information granulation and its centrality in human reasoning and fuzzy logic." *Fuzzy Sets and Systems* 90 (1997): 111–127. Two of the most important early papers for historians are "Outline of a new approach to the analysis of complex systems and decision processes" (1973) and "The concept of a linguistic variable and its applications to approximate reasoning" (1975). With my DynCoopNet project colleague, mathematician Emery A. Coppola, Jr., president of the consulting firm NOAH, I am developing tools, for research and classroom instruction, to help historians incorporate vague, uncertain information into databases requiring precision. We are also completing an article to introduce fuzzy set theory to historians.

[26] Those interested in more information about the M.A. in Historical Resources Management should contact Kevin Marsh, the graduate program director <marskevi@isu.edu>. Information about admissions and the curriculum is available on the department's web site <www.isu.edu/history/>. An illustrated article about the program has been published in the trade journal *ArcNews*, 27, 3 (Fall 2005): 45, and http://www.esri.com/news/arcnews/fall05articles/idaho-state-univ.html, accessed on 22 October 2008.